# *Description of a Strain of* Trypanosoma brucei *from Zululand.*

## Part I.—*Morphology.*

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[PLATES 21-23.]

### INTRODUCTION.

In July, 1912, Dr. A. Theiler, C.M.G., Director of Veterinary Research (Union of South Africa), Pretoria, sent this Commission several blood preparations taken from horses and dogs supposed to be suffering from nagana. Much to the surprise of the Commission, a large percentage of these trypanosomes showed posterior-nuclear forms. This disposed of the contention that the so-called *Trypanosoma rhodesiense* could be distinguished from other species of trypanosomes by this peculiarity, and first led the Commission to suspect that *T. rhodesiense* was in reality *T. brucei.*

Dr. Theiler was then asked to send the living strain through to the Commission in Nyasaland, and this, after several failures, was at last successful.

The history of the strain is as follows: Mr. A. W. Shilston, Veterinary Research Division, Pietermaritzburg, writes that it originated in a mule which was naturally infected at Somkele in Zululand. A dog was inoculated from this mule and brought to the Veterinary Research Laboratory at Pietermaritzburg, where sub-inoculations into a series of animals were made. Mr. Shilston says there is no possibility of this strain having been mixed with any other, as, at the time he was working at it, it was the only species of trypanosome maintained at the laboratory. He also states that he—in order to prove that he was dealing with a single species of trypanosome and not with a mixed infection—infected rabbits with single parasites, and the resulting infections showed the same morphological characters as the original strain.

From Pietermaritzburg the strain was transferred to Pretoria. Mr. William Robertson, acting director during the absence on leave of Dr. Theiler, informs the Commission that the strain was kept going in Pretoria in horses and cattle, in which animals it produced the typical clinical symptoms and *post-mortem* lesions associated with nagana, and that it was always regarded as a pure uncomplicated strain of *T. brucei*. The thanks of the Commission are due to Mr. Robertson for his perseverance in sending inoculated animals to their camp at Kasu. Like the Japanese general outside Port Arthur, as one batch succumbed he sent on another, until at last he succeeded.

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* Major Harvey, R.A.M.C., resigned from the Commission and left Kasu, September 16, 1913. He was succeeded by Captain Watson, R.A.M.C., who arrived November 2, 1913.

The exact length of time this trypanosome was kept going at Pretoria before being sent to Kasu is not given, but the information has been asked for, and will be placed on record as soon as obtained.

In the opinion of the Commission, the trypanosome dealt with in this paper is the same as that discovered by Bruce in Zululand in 1894, and named *T. brucei* by Plimmer and Bradford. Somkele is in the same district in Zululand as that in which this species of trypanosome was first discovered.

In this paper the old Zululand strain will be called the 1896 strain, that being the year in which it was first described; the new strain, the 1913 strain, the year in which it was received from Pretoria.

The Zululand trypanosomes were described by Bruce in his original paper* as hæmatozoa which vary among themselves a good deal in size and shape. Photographs were also given, which show a distinct dimorphic type. In a later paper† Bruce gives measurements of 200 trypanosomes taken from preparations which had been made in Zululand in 1896, and also gives six figures taken from the same source. From these it will be seen that the trypanosome dealt with in Zululand in 1896 was a markedly dimorphic form, with long and slender, intermediate, and short and stumpy forms. From the above measurements and figures there cannot be the slightest shadow of doubt about this.

In 1896 Bruce sent this trypanosome to England, and it was at once placed in the hands of Kanthack, Durham, and Blandford by the Royal Society to be reported on. Their investigation lasted two years, and was published in vol. 64 of the 'Proceedings' of the Royal Society. In regard to the shape of this trypanosome they state that "the Nagana parasites vary considerably both in size and form; they may be long and pointed or blunt-ended and somewhat stouter; some individuals are short and thick, with a short flagellum, their protoplasm being crowded with rounded granules." No one who reads Bruce's 'Progress Report' and compares it with Kanthack, Durham, and Blandford's 1898 report can doubt that the same trypanosome was being dealt with. This trypanosome was distinctly dimorphic.

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* 'Further Report on the Tsetse-fly Disease, or Nagana, in Zululand,' 1896.

† 'Roy. Soc. Proc.,' B, vol. 83, p. 9 (1910).

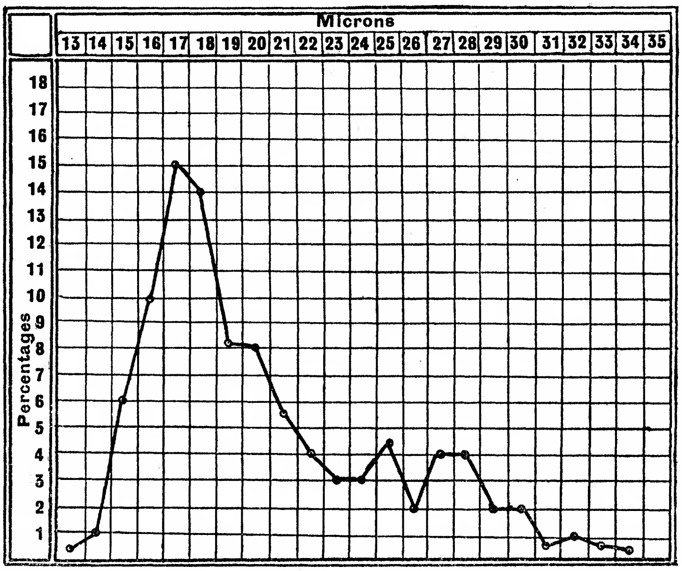
About this time (1898) the trypanosome was handed over to Bradford at the Brown Institute and named *T. brucei* in a paper written in 1899.*

That the trypanosome named by Plimmer and Bradford was the same as that sent to Kanthack, Durham, and Blandford in 1896 there can be no reasonable doubt. There was no other species of pathogenic trypanosome in any English laboratory at the time, with the exception, perhaps, of *T. lewisi*, with which there could be no confusion.

Now, having shown that the original Zululand strain was a well-marked dimorphic type of trypanosome, let us see how it compares with the 1913 strain.

Mr. Shilston kindly sent the Commission a description of this strain made immediately after it had come from Zululand. He states that in the living condition the variation in size and shape of the organism can be observed, the long, slender flagellated forms being readily distinguished from the short, stumpy forms, while all gradations between these two can be found; that the circular vacuole close to the micronucleus is very distinct; and that, although the organisms are actively motile, their progression is not rapid and frequently they simply travel in a small circle.

Chart 1.—Curve representing the Distribution, by Percentages, in respect to Length, of 400 Individuals of *T. brucei*, Zululand Strain, 1913 (Shilston's measurements).



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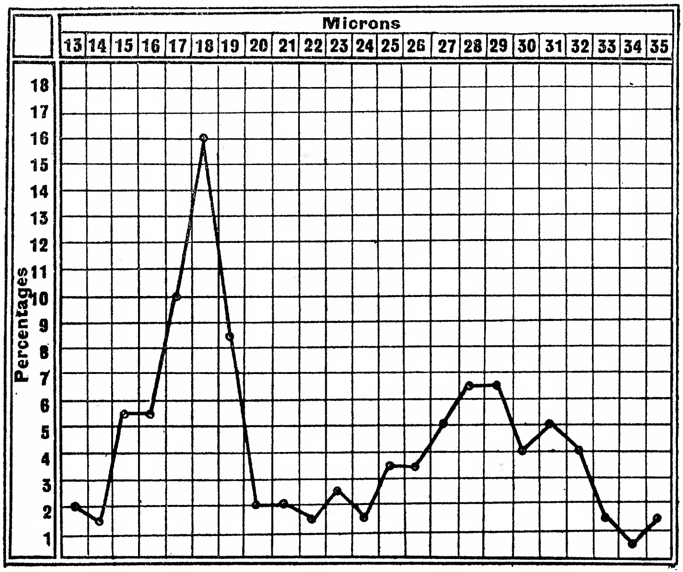
* "A Preliminary Note on the Morphology and Distribution of the Organism found in the Tsetse-fly Disease," by H. G. Plimmer and J. Rose Bradford, 'Roy. Soc. Proc.,' vol. 65, p. 274.

Mr. Shilston also made a large number of measurements of this strain. One of his charts gives the percentages in respect to length of 400 trypanosomes occurring in the mule, dog, and guinea-pig, the measurements being made at varying periods of the disease. This chart is reproduced on p. 495.

In a previous paper* a curve will be found representing the percentages in respect to length of 200 individuals of the original strain of *T. brucei*, measured from old Zululand preparations which had been made in 1896 and were still extant. The numbers making up these two curves are doubtless small, but they are fairly comparable.

Chart 2.—Curve representing the Distribution, by Percentages, in respect to Length, of 200 Individuals of *T. brucei*, Zululand Strain, 1896.



Now although too much weight must not be placed on this comparison, still it must be confessed that the two curves are remarkably alike, and afford a strong argument that Shilston recovered from the Somkele district of Zululand the same species of trypanosome which had been discovered there in 1894. Again, when the action of these two strains on various animals is compared, the same likeness is seen.

Bruce's 1896 strain killed two horses in 30 and 49 days.† Shilston's

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* 'Roy. Soc. Proc.,' B, vol. 83 (1910).

† 'Further Report on the Tsetse-fly Disease, or Nagana, in Zululand,' 1896.

1913 strain killed one horse in 35 days. The former strain killed five dogs in an average of 21 days, the latter four dogs in an average of 19 days.

Taking these various arguments into consideration, it may be assumed that the strain of trypanosome which forms the subject of this paper belongs to the species *T. brucei*, a well-marked dimorphic type of trypanosome.

The object of this paper is to describe as fully as possible the morphology of this new strain of *T. brucei* from Zululand, in order to try to prove its identity with the trypanosome causing disease in man in Northern and Southern Rhodesia, Nyasaland, and German and Portuguese East Africa. The importance of this cannot be overrated. It has been the habit in the past to consider *T. brucei* harmless to man, but if the above conjecture proves to be true, then all *Glossina morsitans* areas where wild game and *T. brucei* co-exist must be looked upon as dangerous. Evidence is accumulating that this is so. Recently two Europeans have fallen victims to the tsetse-fly disease in the Sebungwe district in Southern Rhodesia, a remote, savage, unfrequented spot swarming with game and *G. morsitans*. This year also—1913—as had been anticipated, several cases have been found in the Nyasaland fly-areas to the north and south of the "Proclaimed Area," one case occurring in a native village within a few miles of Zomba, the official capital.

In future papers, the Susceptibility of Animals to this Strain, its Development in *G. morsitans*, Sera Reactions and Cross Inoculation Experiments will be dealt with.

## I. MORPHOLOGY OF T. BRUCEI, ZULULAND STRAIN, 1913.

### A. *Living, Unstained.*

In the living and unstained preparations the dimorphic characteristics of this species can be readily made out. The parasites are actively motile but with restricted translatory movement.

### B. *Fixed and Stained.*

The blood films were fixed, stained and measured as previously described in the 'Proceedings.'*

*Length.*—The following table gives the length of this trypanosome as found in the monkey, dog, guinea-pig and rat, 1000 trypanosomes in all.

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* B, vol. 81 pp. 16 and 17 (1909).

Table I.—Measurements of the Length of *T. brucei*, Zululand, 1913.

| Date. | No. of expt. | Animal. | Method of fixing. | Method of staining. | In microns. | | |
|---|---|---|---|---|---|---|---|
| | | | | | Average length. | Maximum length. | Minimum length. |
| 1913. | | | | | | | |
| Feb. 10 | 1833 | Monkey | Osmic acid | Giemsa | 21·4 | 27·0 | 16·0 |
| ,, 10 | 1835 | ,, | ,, | ,, | 23·2 | 29·0 | 18·0 |
| ,, 10 | 1836 | ,, | ,, | ,, | 23·4 | 30·0 | 18·0 |
| ,, 10 | 1837 | ,, | ,, | ,, | 21·9 | 31·0 | 17·0 |
| ,, 13 | 1834 | ,, | ,, | ,, | 20·3 | 28·0 | 16·0 |
| ,, 13 | 1835 | ,, | ,, | ,, | 19·0 | 24·0 | 12·0 |
| ,, 13 | 1836 | ,, | ,, | ,, | 20·1 | 28·0 | 16·0 |
| ,, 17 | 1834 | ,, | ,, | ,, | 20·6 | 27·0 | 17·0 |
| ,, 20 | 1904 | Dog | ,, | ,, | 22·8 | 29·0 | 19·0 |
| ,, 20 | 1905 | ,, | ,, | ,, | 20·5 | 29·0 | 17·0 |
| ,, 20 | 1907 | ,, | ,, | ,, | 20·6 | 28·0 | 17·0 |
| ,, 20 | 1908 | ,, | ,, | ,, | 20·7 | 30·0 | 18·0 |
| ,, 24 | 1904 | ,, | ,, | ,, | 25·1 | 31·0 | 19·0 |
| ,, 24 | 1905 | ,, | ,, | ,, | 21·1 | 25·0 | 18·0 |
| ,, 24 | 1907 | ,, | ,, | ,, | 20·0 | 30·0 | 16·0 |
| ,, 24 | 1908 | ,, | ,, | ,, | 21·2 | 25·0 | 18·0 |
| ,, 27 | 1904 | ,, | ,, | ,, | 21·7 | 30·0 | 18·0 |
| ,, 27 | 1905 | ,, | ,, | ,, | 21·8 | 31·0 | 18·0 |
| ,, 27 | 1906 | ,, | ,, | ,, | 20·8 | 28·0 | 18·0 |
| ,, 27 | 1907 | ,, | ,, | ,, | 19·1 | 21·0 | 16·0 |
| ,, 27 | 1908 | ,, | ,, | ,, | 24·8 | 32·0 | 18·0 |
| ,, 24 | 1844 | Guinea-pig | ,, | ,, | 27·6 | 35·0 | 18·0 |
| ,, 24 | 1894 | ,, | ,, | ,, | 21·0 | 29·0 | 18·0 |
| ,, 27 | 1843 | ,, | ,, | ,, | 21·9 | 29·0 | 17·0 |
| ,, 27 | 1894 | ,, | ,, | ,, | 21·2 | 31·0 | 17·0 |
| ,, 8 | 1829 | Rat | ,, | ,, | 22·9 | 28·0 | 17·0 |
| ,, 8 | 1829 | ,, | ,, | ,, | 22·5 | 28·0 | 18·0 |
| ,, 8 | 1829 | ,, | ,, | ,, | 21·5 | 26·0 | 18·0 |
| ,, 9 | 1829 | ,, | ,, | ,, | 21·6 | 25·0 | 17·0 |
| ,, 9 | 1829 | ,, | ,, | ,, | 20·9 | 25·0 | 18·0 |
| ,, 9 | 1829 | ,, | ,, | ,, | 20·7 | 24·0 | 17·0 |
| ,, 10 | 1829 | ,, | ,, | ,, | 21·2 | 24·0 | 19·0 |
| ,, 10 | 1829 | ,, | ,, | ,, | 21·6 | 23·0 | 19·0 |
| ,, 10 | 1829 | ,, | ,, | ,, | 21·3 | 24·0 | 17·0 |
| ,, 11 | 1829 | ,, | ,, | ,, | 19·8 | 25·0 | 17·0 |
| ,, 11 | 1829 | ,, | ,, | ,, | 20·5 | 22·0 | 18·0 |
| ,, 11 | 1829 | ,, | ,, | ,, | 20·9 | 25·0 | 18·0 |
| ,, 12 | 1829 | ,, | ,, | ,, | 20·6 | 23·0 | 18·0 |
| ,, 12 | 1829 | ,, | ,, | ,, | 21·7 | 28·0 | 18·0 |
| ,, 12 | 1829 | ,, | ,, | ,, | 21·3 | 25·0 | 19·0 |
| ,, 13 | 1829 | ,, | ,, | ,, | 20·5 | 23·0 | 18·0 |
| ,, 13 | 1829 | ,, | ,, | ,, | 20·0 | 24·0 | 17·0 |
| ,, 13 | 1829 | ,, | ,, | ,, | 20·2 | 23·0 | 17·0 |
| ,, 14 | 1829 | ,, | ,, | ,, | 20·6 | 26·0 | 18·0 |
| ,, 14 | 1829 | ,, | ,, | ,, | 19·5 | 23·0 | 17·0 |
| ,, 14 | 1829 | ,, | ,, | ,, | 20·0 | 22·0 | 17·0 |
| ,, 15 | 1829 | ,, | ,, | ,, | 20·4 | 23·0 | 18·0 |
| ,, 15 | 1829 | ,, | ,, | ,, | 19·7 | 24·0 | 17·0 |
| ,, 15 | 1829 | ,, | ,, | ,, | 20·2 | 22·0 | 18·0 |
| ,, 16 | 1829 | ,, | ,, | ,, | 19·6 | 22·0 | 18·0 |
| | | | | | 21·0 | 35·0 | 12·0 |

The average length of *T. brucei*, Zululand strain, 1913, in the monkey, dog, guinea-pig, and rat, taken from Table I, is as follows :—

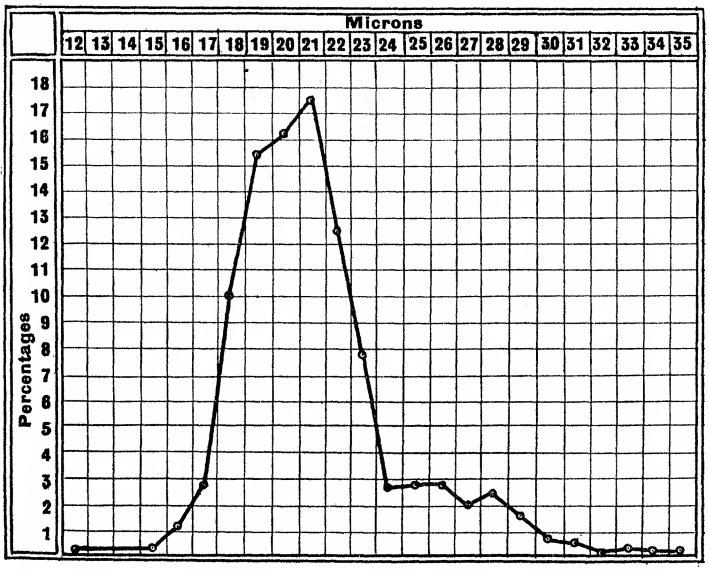
Table II.—Average Length of *T. brucei*, Zululand Strain, 1913.

| Species of animal. | Number of trypanosomes measured. | In microns. | | |
|---|---|---|---|---|
| | | Average length. | Maximum length. | Minimum length. |
| Monkey ............ | 160 | 21 ·2 | 31 ·0 | 12 ·0 |
| Dog .................... | 260 | 21 ·5 | 32 ·0 | 16 ·0 |
| Guinea-pig ......... | 30 | 22 ·9 | 35 ·0 | 17 ·0 |
| Rat .................... | 500 | 20 ·8 | 28 ·0 | 17 ·0 |

The above table shows that a good deal of difference in growth takes place in different animals. Compare, for example, the guinea-pig with the rat: the former with a maximum of 35 microns, the latter with a maximum of only 28 microns.

The next table gives in detail the distribution in respect to length of 1000 trypanosomes. The Commission feel hardly justified in taking up space for this purpose, but it is thought that perhaps in some unknown way these figures may be of use to the statistician.

CHART 3.—Curve representing the Distribution, by Percentages, in respect to Length, of 1000 Individuals of *T. brucei*, Zululand Strain, 1913.



This curve is made up of measurements from 160 specimens of trypanosomes taken from the monkey, 260 from the dog, 80 from the guinea-pig, and 500

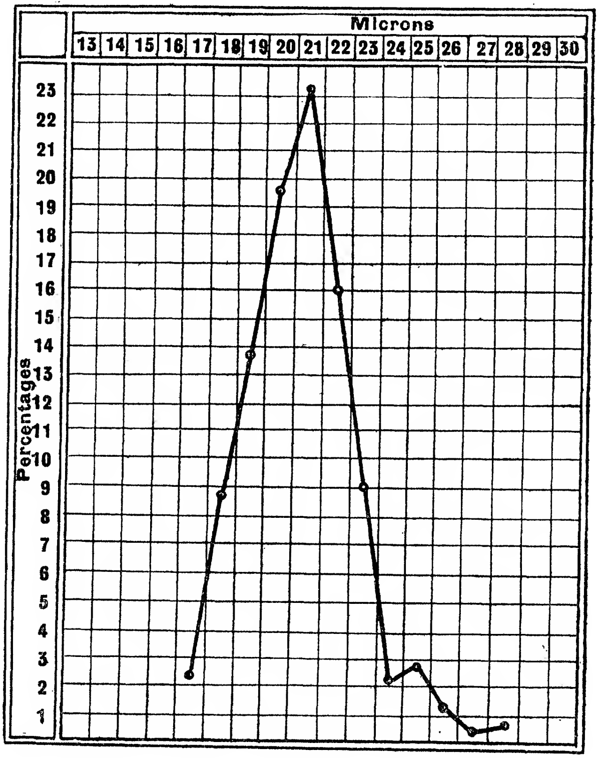
Table III.—Distribution in respect to Length of 500 Individuals of *T. brucei*, Zululand Strain, 1913.

| Animal. | In microns. | | | | | | | | | | | | | | | | | | | | | | | | Average length. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | 28. | 29. | 30. | 31. | 32. | 33. | 34. | 35. | |
| Monkey ...... | — | — | — | — | 1 | — | 4 | 2 | 1 | 1 | 2 | 4 | 2 | 2 | — | 1 | — | — | — | — | — | — | — | — | 21·4 |
| ” ...... | — | — | — | — | — | — | 1 | 2 | 2 | 4 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | — | — | — | — | — | — | 23·2 |
| ” ...... | — | — | — | — | — | — | 2 | 2 | 1 | 1 | 3 | — | 1 | 3 | 5 | — | 1 | — | 1 | — | — | — | — | — | 23·4 |
| ” ...... | — | — | — | — | — | 1 | 1 | 2 | 3 | 4 | 4 | 1 | — | 1 | 1 | — | — | 1 | — | 1 | — | — | — | — | 21·9 |
| ” ...... | — | — | — | — | 4 | — | 1 | 2 | 1 | 4 | 6 | 1 | — | — | — | — | 1 | — | — | — | — | — | — | — | 20·3 |
| ” ...... | 1 | — | — | 2 | 1 | 1 | 1 | 5 | 3 | 2 | 3 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 19·0 |
| ” ...... | — | — | — | — | 3 | 1 | 2 | 6 | 2 | 1 | 1 | — | — | 2 | — | 1 | 1 | — | — | — | — | — | — | — | 20·1 |
| ” ...... | — | — | — | — | — | 2 | — | 5 | 4 | 5 | 1 | — | 1 | — | 1 | 1 | — | — | — | — | — | — | — | — | 20·6 |
| Dog ............ | — | — | — | — | — | — | — | 2 | 2 | 5 | 1 | 5 | 1 | — | — | 2 | — | 2 | — | — | — | — | — | — | 22·8 |
| ” ............ | — | — | — | — | — | 4 | 5 | 3 | 1 | 1 | 1 | 1 | — | — | 2 | — | 1 | 1 | — | — | — | — | — | — | 20·5 |
| ” ............ | — | — | — | — | — | 2 | 4 | — | 2 | 6 | 3 | 2 | — | — | — | — | 1 | — | — | — | — | — | — | — | 20·6 |
| ” ............ | — | — | — | — | — | — | 3 | 3 | 2 | 2 | — | 3 | — | — | 1 | 3 | 2 | — | 1 | — | — | — | — | — | 20·7 |
| ” ............ | — | — | — | — | — | — | — | 3 | 1 | 1 | 1 | 1 | 1 | — | 2 | 3 | 2 | 3 | 1 | 1 | — | — | — | — | 25·1 |
| ” ............ | — | — | — | — | — | — | 2 | 2 | 3 | 5 | 4 | 2 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | 21·1 |
| ” ............ | — | — | — | — | 1 | 2 | 4 | 2 | 4 | 2 | 3 | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | 20·0 |
| ” ............ | — | — | — | — | — | — | 2 | 4 | 3 | 1 | 2 | 6 | — | 2 | — | — | — | — | — | — | — | — | — | — | 21·2 |
| ” ............ | — | — | — | — | — | — | 2 | 4 | 6 | 1 | 1 | — | 2 | — | 1 | 1 | 1 | — | 1 | — | — | — | — | — | 21·7 |
| ” ............ | — | — | — | — | — | — | 1 | 6 | 3 | 2 | 4 | — | — | — | — | 1 | 2 | — | — | 1 | — | — | — | — | 21·8 |
| ” ............ | — | — | — | — | — | — | 3 | 6 | 4 | 2 | — | — | 3 | — | 1 | — | 1 | — | — | — | — | — | — | — | 20·8 |
| ” ............ | — | — | — | — | 1 | 1 | 4 | 6 | 5 | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 19·1 |
| ” ............ | — | — | — | — | — | — | 2 | 3 | 2 | — | 1 | — | — | 1 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | — | — | — | 24·8 |
| Guinea-pig ... | — | — | — | — | — | — | 1 | 1 | — | — | — | 2 | 1 | — | 1 | 1 | 4 | 2 | 1 | 2 | — | 2 | 1 | 1 | 27·6 |
| ” ... | — | — | — | — | — | — | 2 | 6 | 5 | 4 | — | — | — | — | — | 1 | — | 2 | — | — | — | — | — | — | 21·0 |
| ” ... | — | — | — | — | — | 1 | 5 | 2 | 1 | — | 2 | 3 | — | — | 4 | — | 1 | 1 | — | — | — | — | — | — | 21·9 |
| ” ... | — | — | — | — | — | 1 | 4 | 5 | 2 | 2 | 1 | — | 1 | 1 | — | 1 | — | — | 1 | 1 | — | — | — | — | 21·2 |
| Rat ............ | — | — | — | — | — | 1 | — | 1 | 2 | 2 | 3 | 4 | 1 | 2 | 1 | 2 | 1 | — | — | — | — | — | — | — | 22·9 |
| ” ............ | — | — | — | — | — | — | 1 | 2 | 1 | 3 | 4 | 2 | 2 | 2 | 2 | — | 1 | — | — | — | — | — | — | — | 22·5 |
| ” ............ | — | — | — | — | — | — | 2 | 1 | 3 | 6 | 3 | 1 | 1 | 2 | 1 | — | — | — | — | — | — | — | — | — | 21·5 |
| ” ............ | — | — | — | — | — | 1 | 1 | 2 | 1 | 3 | 4 | 5 | 1 | 2 | — | — | — | — | — | — | — | — | — | — | 21·6 |
| ” ............ | — | — | — | — | — | — | 1 | 3 | 5 | 3 | 6 | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | 20·9 |
| ” ............ | — | — | — | — | — | 1 | — | 3 | 3 | 8 | 4 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | 20·7 |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rat ........... | — | — | — | — | — | — | — | 1 | 6 | 6 | 3 | 2 | 2 | — | — | — | — | — | — | — | — | — | — | — | 21·2 |
| ,, ........... | — | — | — | — | — | — | — | 1 | 1 | 6 | 8 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | 21·6 |
| ,, ........... | — | — | — | — | — | 1 | 1 | — | 2 | 4 | 9 | 2 | 1 | — | — | — | — | — | — | — | — | — | — | — | 21·3 |
| ,, ........... | — | — | — | — | — | 1 | 2 | 6 | 5 | 5 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | 19·8 |
| ,, ........... | — | — | — | — | — | — | 1 | 3 | 6 | 5 | 5 | — | — | — | — | — | — | — | — | — | — | — | — | — | 20·5 |
| ,, ........... | — | — | — | — | — | — | 1 | 3 | 6 | 5 | 1 | 2 | — | 2 | — | — | — | — | — | — | — | — | — | — | 20·9 |
| ,, ........... | — | — | — | — | — | — | 3 | 4 | 2 | 5 | 1 | 5 | — | — | — | — | — | — | — | — | — | — | — | — | 20·6 |
| ,, ........... | — | — | — | — | — | — | 1 | 2 | 4 | 4 | 3 | 3 | — | 1 | 1 | — | 1 | — | — | — | — | — | — | — | 21·7 |
| ,, ........... | — | — | — | — | — | — | — | 2 | 5 | 4 | 4 | 4 | — | 1 | — | — | — | — | — | — | — | — | — | — | 21·3 |
| ,, ........... | — | — | — | — | — | — | 3 | 2 | 2 | 10 | 1 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 20·5 |
| ,, ........... | — | — | — | — | — | 1 | 4 | 4 | 2 | 5 | 2 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | 20·0 |
| ,, ........... | — | — | — | — | — | 1 | 3 | 3 | 5 | 2 | 4 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 20·2 |
| ,, ........... | — | — | — | — | — | — | 2 | 2 | 6 | 5 | 3 | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | 20·6 |
| ,, ........... | — | — | — | — | — | 2 | 6 | 2 | 3 | 5 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | 19·5 |
| ,, ........... | — | — | — | — | — | 1 | 1 | 5 | 5 | 6 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | 20·0 |
| ,, ........... | — | — | — | — | — | — | 2 | 3 | 8 | 1 | 4 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 20·4 |
| ,, ........... | — | — | — | — | — | 2 | 2 | 5 | 6 | 3 | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | 19·7 |
| ,, ........... | — | — | — | — | — | — | 2 | 5 | 4 | 5 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — | 20·2 |
| ,, ........... | — | — | — | — | — | — | 5 | 4 | 5 | 5 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 19·6 |
| Total ......... | 1 | — | — | 2 | 11 | 28 | 100 | 153 | 161 | 175 | 125 | 79 | 27 | 28 | 28 | 20 | 24 | 17 | 9 | 7 | 1 | 2 | 1 | 1 | |
| Percentages | 0·1 | — | — | 0·2 | 1·1 | 2·8 | 10·0 | 15·3 | 16·1 | 17·5 | 12·5 | 7·9 | 2·7 | 2·8 | 2·8 | 2·0 | 2·4 | 1·7 | 0·9 | 0·7 | 0·1 | 0·2 | 0·1 | 0·1 | |

from the rat. It is very similar to some of the curves taken from the Nyasaland human strain:* compare Strains II and V. But, on the other hand, it is very unlike some of the others, as for example Strains I and II.

Chart 4.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of *T. brucei*, Zululand Strain, 1913, taken on nine consecutive days from Rat 1829.

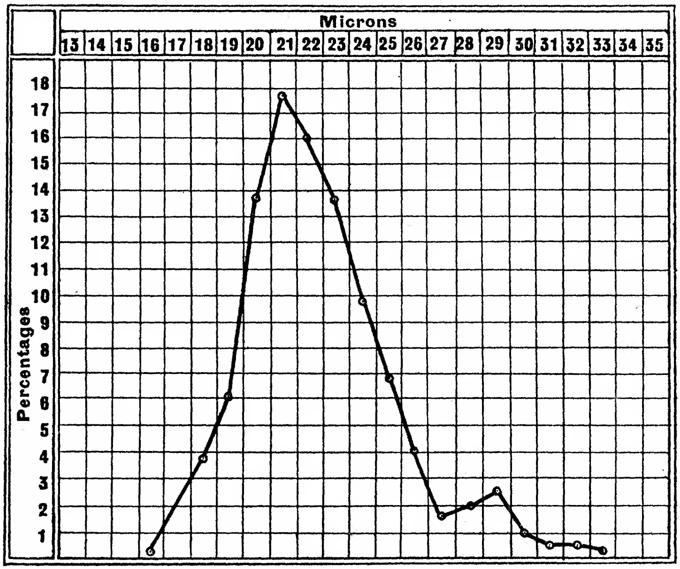


This is rather a peculiar curve, but is not unlike curves obtained in a similar way from the trypanosome causing disease in man in Nyasaland, as the following chart will show:—

---

* 'Roy. Soc. Proc.,' B, vol. 86, pp. 285-302.

Chart 5.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of the Trypanosome causing Disease in Man in Nyasaland, taken on nine consecutive days from Rat 2300.



The Zululand strain, 1913, has been carried on in horses and cattle for some time in the laboratory at Pretoria, and may have varied somewhat in morphology under these artificial conditions. It will be interesting to see what change, if any, is induced by passage through *G. morsitans.* The three following curves represent first, second and third passages :—

Chart 6.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of *T. brucei*, Zululand Strain, 1913, after first passage through *G. morsitans*, taken on nine consecutive days from Rat 2006.

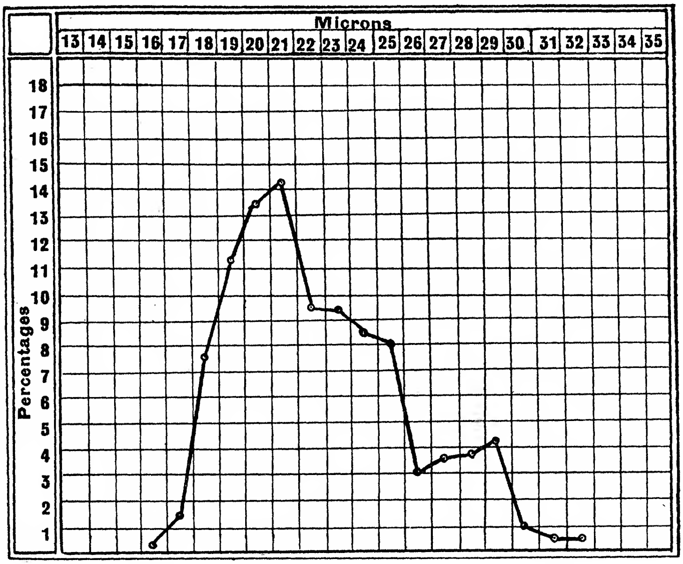


Chart 7.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of *T. brucei*, Zululand Strain, 1913, after second passage through *G. morsitans*, taken on nine consecutive days from Rat 2288.

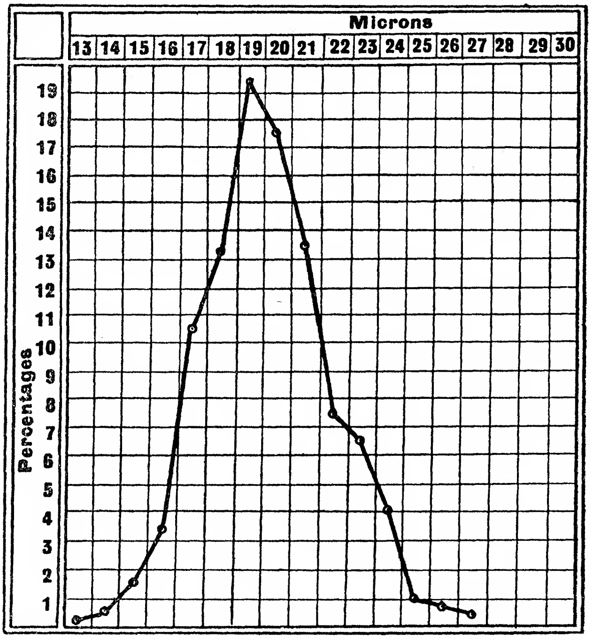
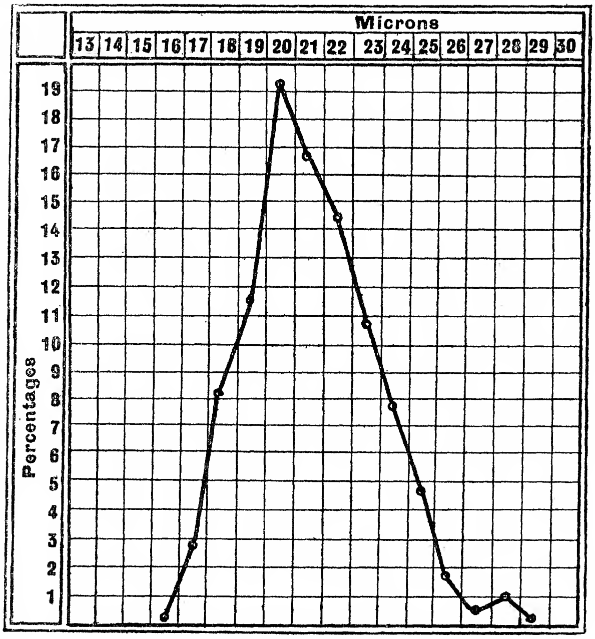


Chart 8.—Curve representing the Distribution, by Percentages, in respect to Length, of 500 Individuals of *T. brucei*, Zululand Strain, 1913, after third passage through *G. morsitans*, taken on nine consecutive days from Rat 2406.



From this curve it will be seen that three passages through *G. morsitans* has had little or no effect in changing the character of this trypanosome as regards distribution of length. It has usually been thought that a trypanosome kept under laboratory conditions, and without the opportunity of passage through its invertebrate host, the tsetse fly, would tend to change in morphology. These curves, on the other hand, show that a trypanosome, after passage through horses and cattle for some years—exact time unknown—is unchanged by three passages through its invertebrate host, *G. morsitans.*

Table IV.—Distribution in respect to Length of 500 Individuals of *T. brucei*, Zululand Strain, 1913, after first passage through *G. morsitans.*

| Animal. | In microns. | | | | | | | | | | | | | | | | | Average length. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | 28. | 29. | 30. | 31. | 32. | |
| Rat ............ | — | 1 | 1 | 5 | — | 2 | 1 | 1 | 4 | 1 | — | 2 | — | 2 | — | — | — | 22·5 |
| " ............ | — | — | — | 1 | 3 | — | 4 | 3 | 1 | 3 | — | 1 | 3 | — | 1 | — | — | 23·8 |
| " ............ | — | 1 | 3 | — | 1 | 4 | 2 | 4 | 1 | 1 | 1 | — | 1 | 1 | — | — | — | 22·1 |
| " ............ | — | — | 3 | — | 5 | 2 | 3 | 3 | 1 | 2 | — | — | — | 1 | — | — | — | 21·7 |
| " ............ | — | 1 | 1 | 1 | 2 | 6 | 3 | 1 | 4 | — | — | — | 1 | — | — | — | — | 21·4 |
| " ............ | — | — | 2 | — | 3 | 6 | 4 | 2 | 2 | 1 | — | — | — | — | — | — | — | 21·4 |
| " ............ | — | — | — | 3 | 4 | 4 | 2 | 2 | 1 | 1 | — | 1 | 1 | — | — | — | 1 | 22·3 |
| " ............ | — | — | 3 | 1 | 8 | 3 | — | 1 | 1 | 2 | — | 1 | — | — | — | — | — | 21·0 |
| " ............ | — | — | 3 | 3 | 5 | 1 | 2 | 2 | — | — | — | 2 | — | 2 | — | — | — | 21·7 |
| " ............ | — | — | 2 | 2 | 1 | — | 1 | 2 | 2 | 1 | 1 | — | 2 | 4 | 2 | — | — | 24·6 |
| " ............ | — | — | — | 3 | 3 | 1 | 1 | — | 2 | 4 | 1 | — | 1 | 2 | — | 1 | 1 | 24·1 |
| " ............ | — | — | 1 | 2 | — | 1 | — | 3 | 4 | 4 | 1 | 1 | 1 | 2 | — | — | — | 24·0 |
| " ............ | — | — | 2 | 4 | 1 | 1 | 4 | — | 2 | 3 | — | 2 | — | — | 1 | — | — | 22·4 |
| " ............ | — | — | 1 | 1 | 1 | 1 | 2 | 2 | 5 | 3 | 2 | — | — | 1 | — | 1 | — | 23·7 |
| " ............ | — | — | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | — | 1 | — | — | — | 23·3 |
| " ............ | — | 2 | 2 | 2 | 1 | 3 | 1 | 3 | 2 | 1 | — | 2 | — | 1 | — | — | — | 21·9 |
| " ............ | — | 1 | 3 | 1 | 2 | 3 | 4 | — | — | 4 | — | — | 2 | — | — | — | — | 21·8 |
| " ............ | — | — | 2 | 3 | 2 | 5 | 1 | 5 | — | 1 | — | 1 | — | — | — | — | — | 21·3 |
| " ............ | — | — | 1 | 5 | 4 | 5 | 1 | — | — | — | 2 | 1 | — | 1 | — | — | — | 21·4 |
| " ............ | 1 | — | 1 | 1 | 3 | 3 | 2 | 4 | 1 | 1 | — | — | 2 | 1 | — | — | — | 22·3 |
| " ............ | — | — | 1 | 5 | 1 | 4 | 2 | 1 | 3 | — | 1 | — | 1 | 1 | — | — | — | 21·9 |
| " ............ | — | — | 1 | 4 | 5 | 4 | 1 | 2 | — | 1 | — | 1 | 1 | — | — | — | — | 21·3 |
| " ............ | — | — | 1 | 2 | 3 | 5 | 2 | 2 | 1 | 1 | 1 | 1 | — | 1 | — | — | — | 22·1 |
| " ............ | — | — | — | 1 | 4 | 4 | 3 | 1 | 2 | 2 | 1 | — | 1 | — | 1 | — | — | 22·7 |
| " ............ | — | 1 | 3 | 5 | 4 | 1 | — | — | 1 | — | 2 | 1 | 2 | — | — | — | — | 21·3 |
| Total............ | 1 | 7 | 38 | 56 | 67 | 71 | 48 | 47 | 43 | 40 | 15 | 18 | 19 | 21 | 5 | 2 | 2 | |
| Percentages ... | 0·2 | 1·4 | 7·6 | 11·2 | 13·4 | 14·2 | 9·6 | 9·4 | 8·6 | 8·0 | 3·0 | 3·6 | 3·8 | 4·2 | 1·0 | 0·4 | 0·4 | |

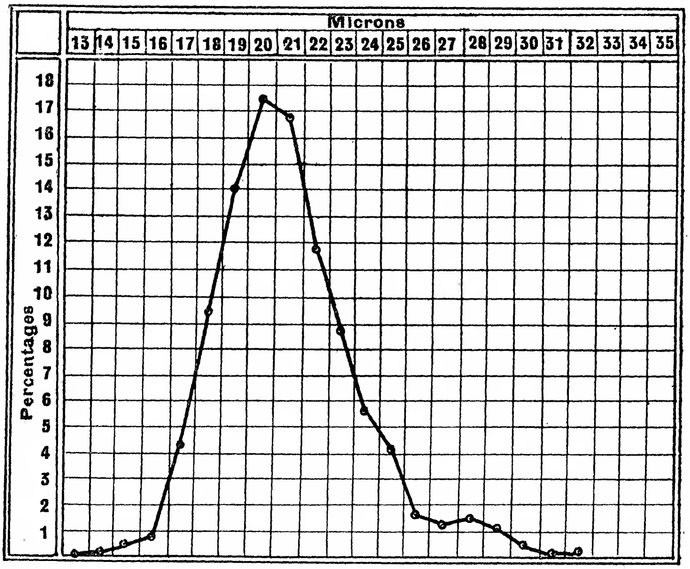
Table V.—Distribution in respect to Length of 500 Individuals of *T. brucei*, Zululand Strain, 1913, after second passage through *G. morsitans*.

| Animal. | In microns. | | | | | | | | | | | | | | | Average length. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | |
| Rat .............. | — | — | — | — | 1 | 2 | — | 5 | 4 | 2 | 3 | 2 | 1 | — | — | 21·1 |
| ,, .............. | — | — | — | — | 2 | — | 4 | 3 | 3 | 1 | 4 | 2 | — | 1 | — | 21·0 |
| ,, .............. | — | — | — | — | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 4 | 1 | 2 | — | 21·7 |
| ,, .............. | — | — | — | — | 1 | 3 | 4 | 5 | 4 | 2 | 1 | — | — | — | — | 19·9 |
| ,, .............. | — | — | — | — | 2 | 2 | 9 | 3 | 3 | 1 | — | — | — | — | — | 19·3 |
| ,, .............. | — | — | 1 | — | 3 | 2 | 5 | 5 | 4 | — | — | — | — | — | — | 19·0 |
| ,, .............. | — | — | 1 | 3 | 4 | — | 5 | 1 | 2 | 1 | 1 | 1 | 1 | — | — | 19·1 |
| ,, .............. | — | — | 1 | — | 5 | 2 | 2 | 4 | 4 | 1 | — | — | — | — | 1 | 19·3 |
| ,, .............. | — | — | — | 2 | — | 2 | 5 | 3 | 2 | 4 | 2 | — | — | — | — | 19·9 |
| ,, .............. | — | — | — | 2 | 1 | 3 | 3 | 5 | 3 | — | 2 | 1 | — | — | — | 19·6 |
| ,, .............. | — | — | 1 | — | 2 | 3 | 5 | 5 | 3 | — | — | — | — | — | 1 | 19·4 |
| ,, .............. | — | — | — | 1 | 3 | 4 | 1 | 3 | 4 | 2 | 1 | — | — | 1 | — | 19·7 |
| ,, .............. | — | 2 | 1 | 3 | 4 | 3 | 2 | 2 | 2 | 1 | — | — | — | — | — | 17·7 |
| ,, .............. | 1 | — | — | 1 | 2 | 4 | 6 | 3 | — | — | 3 | — | — | — | — | 18·9 |
| ,, .............. | — | — | 1 | 1 | 6 | 5 | 3 | 3 | — | — | 1 | — | — | — | — | 18·1 |
| ,, .............. | — | — | — | 2 | 3 | 5 | 2 | 3 | 1 | 2 | 1 | 1 | — | — | — | 19·1 |
| ,, .............. | — | — | — | — | 2 | 1 | 7 | 5 | 4 | 1 | — | — | — | — | — | 19·5 |
| ,, .............. | — | — | — | — | 4 | 3 | 4 | 4 | 3 | — | 1 | 1 | — | — | — | 19·4 |
| ,, .............. | — | — | 1 | 1 | 3 | 3 | 3 | 2 | 5 | 1 | 1 | — | — | — | — | 19·1 |
| ,, .............. | — | — | 1 | — | — | 2 | 5 | 5 | — | 6 | 1 | — | — | — | — | 20·0 |
| ,, .............. | — | — | — | — | — | 1 | 7 | 5 | 3 | 1 | 1 | 2 | — | — | — | 20·3 |
| ,, .............. | — | — | — | — | 1 | 2 | 4 | 5 | 2 | 2 | 2 | 2 | — | — | — | 20·4 |
| ,, .............. | — | — | — | — | 2 | 2 | 2 | 1 | 4 | 5 | 3 | — | 1 | — | — | 20·8 |
| ,, .............. | — | — | — | — | 1 | 3 | 2 | 2 | 3 | 3 | 1 | 4 | 1 | — | — | 21·1 |
| ,, .............. | — | — | — | 1 | — | 7 | 5 | 3 | 2 | — | 2 | — | — | — | — | 19·2 |
| Total ......... | 1 | 2 | 8 | 17 | 53 | 66 | 97 | 88 | 67 | 37 | 33 | 20 | 5 | 4 | 2 | |
| Percentages ... | 0·2 | 0·4 | 1·6 | 3·4 | 10·6 | 13·2 | 19·4 | 17·6 | 13·4 | 7·4 | 6·6 | 4·0 | 1·0 | 0·8 | 0·4 | |

Table VI.—Distribution in respect to Length of 500 Individuals of *T. brucei*, Zululand Strain, 1913, after third passage through *G. morsitans*.

| Animal. | In microns. | | | | | | | | | | | | | | Average length. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | 28. | 29. | |
| Rat ............ | — | — | 1 | 2 | 3 | 2 | 5 | 4 | 2 | 1 | — | — | — | — | 21·6 |
| ,, ............ | — | — | 3 | 1 | 3 | 5 | 3 | — | 2 | 3 | — | — | — | — | 21·3 |
| ,, ............ | — | 1 | 1 | — | 3 | 6 | 3 | 4 | — | 2 | — | — | — | — | 21·4 |
| ,, ............ | — | — | 2 | 1 | 2 | 6 | 1 | 4 | 2 | — | 1 | — | 1 | — | 21·8 |
| ,, ............ | — | — | 1 | 1 | 1 | 3 | 3 | 5 | 4 | 2 | — | — | — | — | 22·3 |
| ,, ............ | — | — | 2 | 2 | 5 | 2 | 2 | 3 | 2 | — | 1 | 1 | — | — | 21·5 |
| ,, ............ | — | — | — | 3 | 5 | 8 | 2 | 1 | 1 | — | — | — | — | — | 20·8 |
| ,, ............ | — | 1 | 1 | 4 | 5 | 2 | 3 | 2 | 1 | 1 | — | — | — | — | 20·7 |
| ,, ............ | — | 1 | 1 | 3 | 2 | 7 | 3 | 1 | 1 | — | — | — | 1 | — | 21·0 |
| ,, ............ | — | 2 | — | 3 | 4 | 1 | 5 | 4 | 1 | — | — | — | — | — | 20·8 |
| ,, ............ | — | — | 1 | 3 | 6 | 4 | 2 | 2 | 2 | — | — | — | — | — | 20·8 |
| ,, ............ | — | — | 1 | 1 | 3 | 4 | 2 | 5 | 2 | 1 | 1 | — | — | — | 21·9 |
| ,, ............ | — | — | 1 | 4 | 2 | 1 | 1 | 2 | 3 | 5 | 1 | — | — | — | 22·3 |
| ,, ............ | 1 | — | 3 | 3 | 3 | — | 4 | 3 | — | 1 | 1 | — | 1 | — | 21·1 |
| ,, ............ | — | — | 1 | 2 | 2 | 1 | 8 | 1 | 3 | 1 | — | — | — | 1 | 22·1 |
| ,, ............ | — | 2 | 1 | 1 | 7 | 3 | 2 | 2 | 1 | 1 | — | — | — | — | 20·6 |
| ,, ............ | — | — | 2 | 2 | 4 | 6 | 3 | 1 | — | 1 | — | 1 | — | — | 21·0 |
| ,, ............ | — | — | 3 | 3 | 8 | 1 | 1 | — | 2 | — | 1 | — | 1 | — | 20·8 |
| ,, ............ | — | 1 | 1 | 5 | 4 | 1 | 2 | 1 | 2 | 2 | 1 | — | — | — | 21·1 |
| ,, ............ | — | 1 | 3 | 3 | 2 | 4 | 3 | 3 | 1 | — | — | — | — | — | 20·5 |
| ,, ............ | — | 1 | 4 | 3 | 5 | 2 | 1 | 2 | — | 2 | — | — | — | — | 20·3 |
| ,, ............ | — | — | 3 | 1 | 5 | 4 | 4 | — | 2 | — | — | — | 1 | — | 21·0 |
| ,, ............ | — | 2 | 1 | 1 | 5 | 2 | 4 | 2 | 1 | 1 | 1 | — | — | — | 21·1 |
| ,, ............ | — | 2 | 3 | 3 | 1 | 4 | 4 | 1 | 2 | — | — | — | — | — | 20·4 |
| ,, ............ | — | — | 1 | 3 | 6 | 5 | 1 | 1 | 2 | — | 1 | — | — | — | 20·9 |
| Total ......... | 1 | 14 | 41 | 58 | 96 | 84 | 72 | 54 | 39 | 24 | 9 | 2 | 5 | 1 | |
| Percentages | 0·2 | 2·8 | 8·2 | 11·6 | 19·2 | 16·8 | 14·4 | 10·8 | 7·8 | 4·8 | 1·8 | 0·4 | 1·0 | 0·2 | |

Chart 9.—Curve representing the Distribution, by Percentages, in respect to Length, of 2000 Individuals of *T. brucei*, Zululand Strain, 1913, taken on nine consecutive days from Rats 1829, 2006, 2288, and 2406.



As Shilston's mule was in all probability infected from the wild game of the Somkele district, in Zululand, it will be interesting to compare this curve with that of the trypanosome causing disease in man, taken from the wild game in Nyasaland.

Chart 10.—Curve representing the Distribution, by Percentages, in respect to Length, of 2500 Individuals of the Trypanosome causing Disease in Man in Nyasaland, the Wild-game Strain, taken on nine consecutive days from Rats 847, 1220, 992, 849, and 1022.

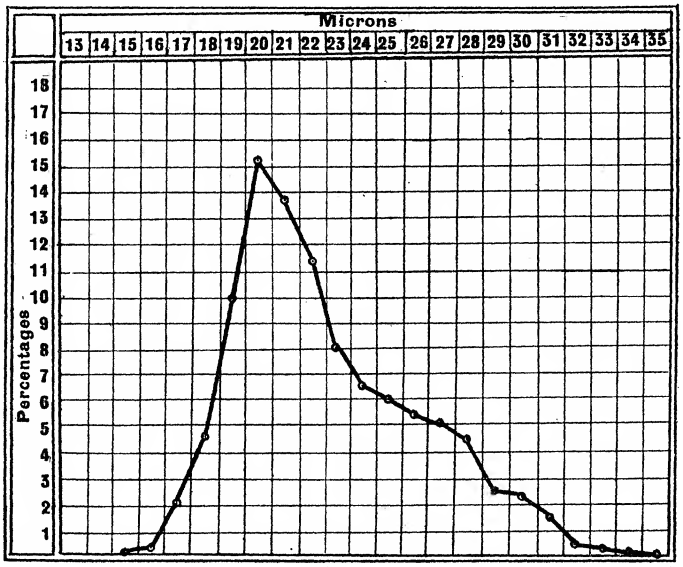


Table VII.—Percentage of Posterior-Nuclear Forms found among the Short and Stumpy Varieties of *T. brucei*, Zululand Strain, 1913.

| Date. | Experiment No. | Animal. | Percentage among short and stumpy forms. |
|---|---|---|---|
| 1912. | | | |
| June 22 | I | Horse | 30 |
| ,, 25 | II | ,, | 65 |
| — | I | Dog | 5 |
| June 21 | II | ,, | Nil |
| 1913. | | | |
| Feb. 8 | 1828 | Rat | 1 |
| ,, 9 | 1828 | ,, | 37 |
| ,, 10 | 1828 | ,, | 63 |
| ,, 11 | 1828 | ,, | 36 |
| ,, 12 | 1828 | ,, | 32 |
| ,, 13 | 1828 | ,, | 17 |
| ,, 14 | 1828 | ,, | 54 |
| ,, 15 | 1828 | ,, | 45 |
| ,, 16 | 1828 | , | 20 |
| ,, 17 | 1828 | ,, | 17 |
| Mar. 24 | 2006 | ,, | 10 |
| ,, 25 | 2006 | ,, | 54 |
| ,, 26 | 2006 | ,, | 41 |
| ,, 27 | 2006 | ,, | 18 |
| ,, 28 | 2006 | ,, | 38 |
| ,, 29 | 2006 | ,, | 32 |
| Apr. 1 | 2006 | ,, | 69 |
| Mar. 2 | 2006 | ,, | 74 |
| ,, 3 | 2006 | ,, | 63 |
| ,, 7 | 2006 | ,, | 74 |
| July 21 | 2288 | ,, | Nil |
| ,, 22 | 2288 | ,, | 42 |
| ,, 23 | 2288 | ,, | 20 |
| ,, 24 | 2288 | ,, | 35 |
| ,, 25 | 2288 | ,, | 16 |
| ,, 26 | 2288 | ,, | 29 |
| ,, 27 | 2288 | ,, | 43 |
| ,, 28 | 2288 | ,, | 52 |
| ,, 29 | 2288 | ,, | 49 |
| ,, 30 | 2288 | ,, | 61 |
| — | I | Mouse | 5 |
| | | Average | 37·8 |

These two curves are undoubtedly much alike, and as the wild-game strain in Nyasaland is supposed to be identical with the human strain, then it might be said that *T. brucei*, Zululand strain, 1913, is also identical with the trypanosome causing disease in man in Nyasaland. Others will say that the Zululand trypanosome and the Nyasaland wild-game strain are both *T. brucei*, but that this does not prove that *T. brucei* is identical with the human strain. No, but if it is shown that *T. brucei*, Zululand, is absolutely identical in morphology with this Nyasaland human strain, that it also has exactly the same disease-producing power on the various experimental animals, this will go a good long way to make the ordinary unprejudiced man chary of exposing himself too carelessly to the so-called harmless nagana. His serum may save him as a rule, but there may come a time when—his resistance being lowered either by fatigue, or some other cause—the trypanosome may gain a footing, and then his belief in the written word of the text-book will receive a rude shock.

*Breadth.*—The long and slender average 2·76 microns in breadth, the intermediate 3·25, and the short and stumpy 3·53. This measurement was made across the broadest part of the trypanosome and includes the undulating membrane. Most previous measurements of breadth have not included this.

In regard to the shape of this trypanosome, contents of cell, nucleus micronucleus, undulating membrane, and flagellum, it is not proposed to describe these characters separately for this strain as was done in the case of the trypanosome causing disease in man in Nyasaland. Suffice it to say that, after the most careful comparison, no difference whatever can be made out in the morphology of the two trypanosomes. At the end of this paper three plates are given, one representing the short and stumpy, another the intermediate, and a third the long and slender forms. If these plates are compared with those given in previous papers* it will be seen that in morphology the Nyasaland and Zululand trypanosomes are identical.

## CONCLUSIONS.

1. The trypanosome described in this paper under the name of the "Zululand strain, 1913," is the same species as that discovered by Bruce in Zululand in 1894; reported on by Kanthack, Durham and Blandford in 1898; and named *T. brucei* by Plimmer and Bradford in 1899.

2. As regards its morphology, this trypanosome is absolutely identical with the trypanosome causing disease in man in Nyasaland, the *T. rhodesiense* of Stephens and Fantham.

## DESCRIPTION OF PLATES.

### PLATE 21.

*Trypanosoma brucei*, Zululand strain, 1913, short and stumpy forms. × 2000.

### PLATE 22.

*Trypanosoma brucei*, Zululand strain, 1913, intermediate forms. × 2000.

### PLATE 23.

*Trypanosoma brucei*, Zululand strain, 1913, long and slender forms. × 2000.

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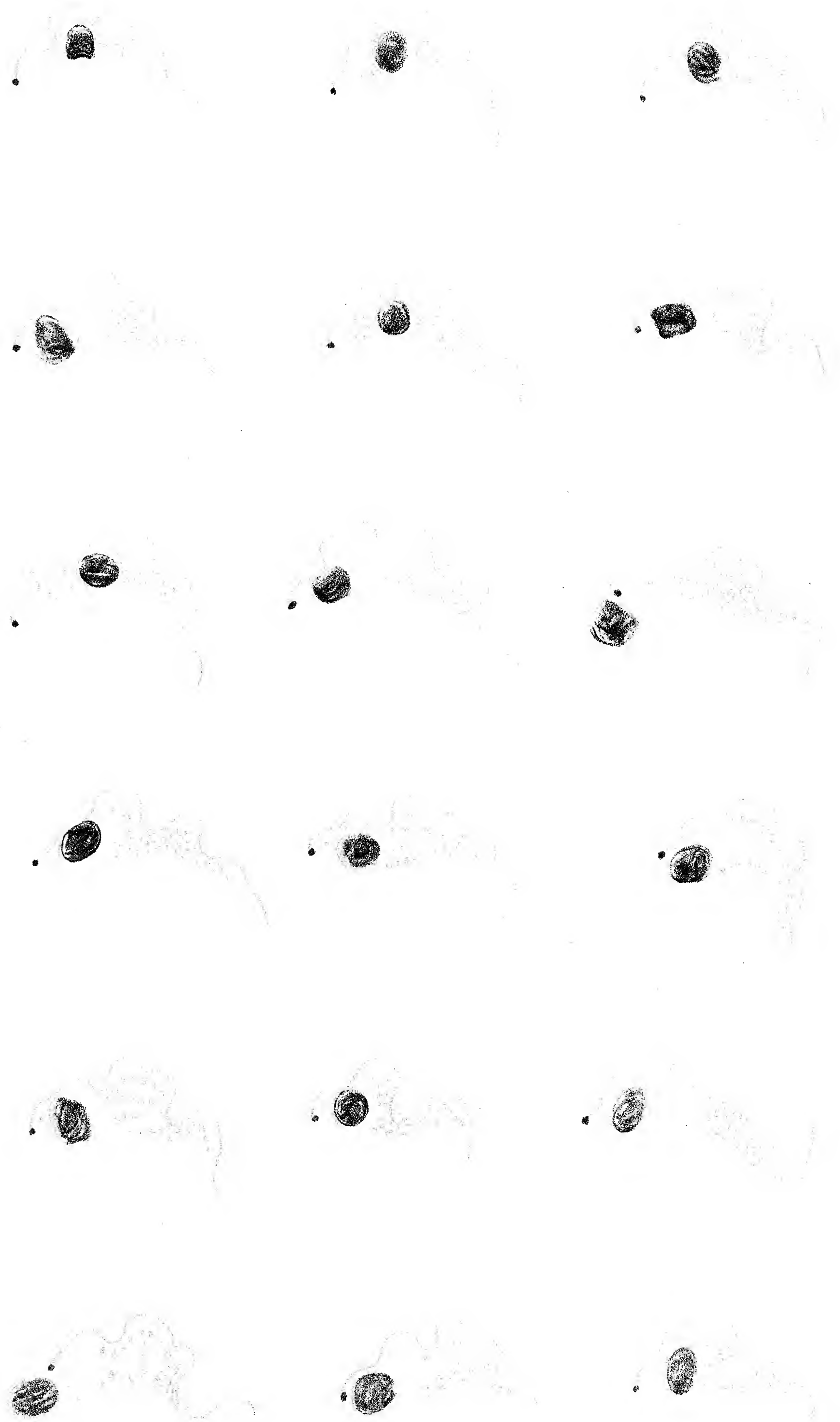
* 'Roy. Soc. Proc.,' B, vol. 85, p. 433 (1912), and vol. 87, p. 35 (1913).



Short & Stumpy.

M. E. Bruce del.

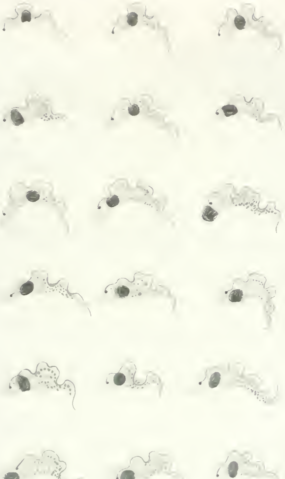
Intermediate.

M. E. Bruce, del.

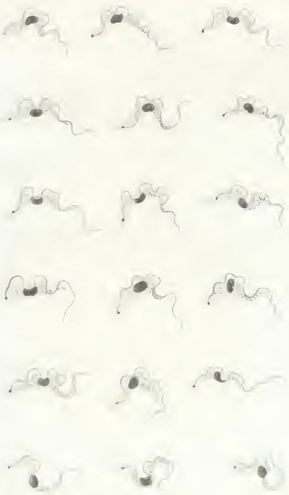
Sir David Bruce & others. Roy. Soc. Proc. B. vol. 87, Pl. 23.

Long & Slender.

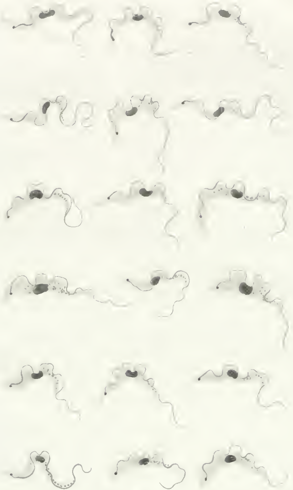
M. E. Bruce. del.



[illegible]



*Intermediate*



*Long & Slender*